



TECH TRENDS

The Applied Technologies Journal for Superfund Removals & Remedial Actions & RCRA Corrective Actions

COLD CLIMATE SOIL BIOVENTING

A field demonstration of soil vapor extraction (SVE) and bioventing to remove hydrocarbons from above the ground water table at Gulf Canada Resources Limited's Strachan Gas Plant represents the first documented evidence in Canada of the practicality of using these technologies in colder climates. The results show that the addition of bioventing to conventional SVE enhances remediation and reduces costs by as much as 50% over conventional SVE. Bioventing uses lower air flow rates than conventional SVE; as a result, blower and operating costs are reduced compared to SVE, with little or no off-gas treatment required. The SVE/bioventing demonstrations are part of a series of field demonstrations of remedial technologies applicable to the unique problems encountered in the natural gas processing industry. The project is a joint project of the Canadian Association of Petroleum Producers (CAPP),

the Government of Canada and the U.S. Department of Energy.

The site, located in Alberta, Canada, is contaminated by a complex mixture of natural gas condensate liquids, polyaromatic hydrocarbons (PAHs), dissolved volatile organic compounds (including the BTEX compounds of benzene, toluene, ethylbenzene and xylene) and gas-processing chemicals such as amines and amine degradation products. There is free-phase natural gas condensate in addition to a dissolved hydrocarbon plume in glaciofluvial sands and gravels and fractured bedrock. In the hydrocarbon plume, BTEX concentrations average about 10 to 20 milligrams per liter. The SVE/bioventing demonstrations focus on removing hydrocarbons from above the ground water table. The first phase of work was not optimized for removal by SVE and bioventing.

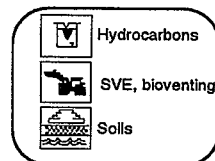
After the first month of conventional SVE operation, the system was shut down for one month to allow subsurface conditions to equilibrate and to allow an extended respiration test to be performed. This type of test involved determining whether aerobic biodegradation was occurring in the subsurface by measuring changes in the oxygen (O_2) and carbon dioxide (CO_2) concentrations in the soil gas over time. Biodegradation can be indirectly monitored by observing changes in O_2 and CO_2 over time. Oxygen levels in the soil were seen to decrease over this period, from approximately 21% (atmospheric concentration) to less than 3%, while CO_2 concentrations increased from less than 1% to approximately 8-12%. Based on these

calculations, it was estimated that about 450 kilograms (kg) of hydrocarbons were biodegraded.

The next step in the project was to examine the effects of bioventing (Phase I bioventing). Data collected over the next four-month period spanning the relatively warm late summer to mid-winter 1994 indicated that about 3,500 kg of contaminant were degraded through bioventing. Air extraction rates below 50 liters per second were insufficient to maintain rapid biodegradation. A series of additional respiration tests were then run over the winter months, during which time the subsurface temperatures dropped from 9 degrees Celsius (C) in October to around 4 degrees C by March. The data showed that biological degradation continued to occur at significant rates. The oxygen concentration dropped substantially from atmospheric levels (21%). The corresponding rise in CO_2 concentrations indicated that the changes were due to bioactivity.

Continuing cold climate testing from December 1994 to the present show that the biodegradation rates remain very high, averaging approximately 200 kg of hydrocarbon biodegraded per day during the winter. During this period surface temperatures dropped as low as -35 degrees C, although subsurface temperatures ranged from a high of 10 degrees in the fall to a low of 5 degrees C in the spring.

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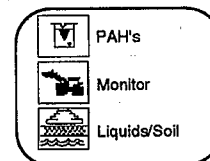
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Field Portable Monitors

FIELD PORTABLE MONITOR FOR PAHS

By William H. Engelmann,
EPA's Environmental Monitoring System Laboratory, Las Vegas



The Field-Portable Scanning Spectrofluorometer (FPSS) has tackled the difficult task of providing immediate in situ screening for polyaromatic hydrocarbons (PAHs) in complex mixtures such as oils, creosotes and tars. The FPSS, developed by Tuan Vo-Dinh and coworkers at Oak Ridge National Laboratory for EPA's Environmental Monitoring Systems Laboratory in Las Vegas, Nevada (EMSL-LV), has overcome the challenge presented by the high molecular weight of these compounds since spectrofluorometry can readily measure their relatively high luminescence yields. Heretofore these heavy compounds have been troublesome to analyze with traditional gas chromatography. Additionally, the FPSS can provide measurements into the low part-per-billion (ppb) range, or even lower, for not only PAHs but also oils, polychlorinated biphenyls, phenols, dioxins and most pesticides.

The FPSS performs in either emission or synchronous wavelength scan modes. The latter mode scans both excitation and emission monochromators simultaneously with a small, constant wavelength offset. The result is a simplified synchronous spec-

trum with more spectral resolution.

Advantages of the synchronous mode include: (1) spectral peaks are simplified and sharpened; (2) mixed PAHs with differing numbers of fused rings are spaced out spectrally with no overlap, allowing unambiguous assignment to individual PAHs; and (3) the relative amounts of the various PAHs in a mixture are easily estimated. The emission mode has a slightly higher sensitivity and is useful for determining the total PAHs in a mixture, or in identifying spectral classes of PAHs, oils or tars. In the synchronous scanning mode, it can detect anthracene—a typical PAH—at about 3.5 ng/mL (nanograms per milliliter). In the emission mode, anthracene can be detected at about 0.5 ng/mL.

The FPSS consists of three parts: a small suitcase-sized instrument that houses the optics and electronics; a battery pack; and a laptop computer used for instrument control, data storage and analysis. The spectral coverage of the instrument is 210 to 650 nanometers. The instrument parameters are chosen by the operator through computer control.

The FPSS can be operated two ways: using a standard fluorescence

cuvette cell or a bifurcated optical fiber. The cuvette can be used with liquid samples or extracts of soils. The optical fiber attachment allows direct screening of water samples.

The prototype of the FPSS has been demonstrated at Region 4's American Creosote Works Superfund site near Jackson, Tennessee. These results have been so promising that they have merited the presentation at two recent technical symposia; these findings are being published in the Proceedings. The FPSS will be further demonstrated at sites in Regions 6 and 8. The prototype FPSS currently is available for performance comparison at sites by Remedial Project Managers and On Scene Coordinators. *If you think that your site may be a candidate, contact Ken Brown at EMSL-LV at 702-798-2270.*

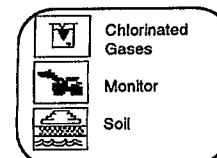
The prototype is ready for commercial manufacturing; and, EMSL-LV and Oak Ridge National Laboratory will transfer the technology to a commercial manufacturer.

For more information, call Bill Engelmann at EMSL-LV at 702-798-2664 by phone or at 702-798-2107 by FAX.

SITE SEARCH TO EVALUATE SOIL-GAS MONITOR

The EPA is adapting the U.S. Army's hand-held chemical agent monitor (CAM) to the area of environmental risk assessment analysis. The monitor is now ready for a field demonstration and evaluation; and, EPA's Environmental Monitoring Systems Laboratory at Las Vegas (EMSL-LV) is searching for a site to field evaluate this innovative technology. EMSL-LV, together with Washington State University, built the prototype field monitor that couples gas chromatography with a Fourier transform ion mobility spectrometer (GC-FTIMS). The monitor is a good candidate for on-site detection of vinyl chloride, other

chlorinated gases and many chlorinated solvents that are regulated at concentrations near the one part per billion level in soils and water. These compounds are frequently trapped in the soil-gas spaces and are difficult to analyze because of the physical problems of obtaining and preserving the sample as well as the challenges inherent in the subsequent analysis. The GC-FTIMS is particularly well suited for this type of analysis because it merges the separation power of capillary gas chromatography with the sensitivity of ion mobility spectrometry and incorporates a Fourier transform to achieve ruggedness for in situ analysis. The GC-FTIMS offers an



alternative to 100% laboratory analysis of samples. The GC-FTIMS has been tested in the laboratory and has turned out good results.

If you think your site is a good candidate for a field evaluation of the monitor, call Ken Brown at the EMSL-LV Technology Support Center at 702-798-2270.

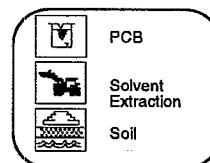
Here's how it works. Reactive ions are formed from air or carrier gas molecules by using either a nickel-63
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SITE Subjects



PCB SOIL SOLVENT EXTRACTION

By Mark Meckes, EPA Risk Reduction Engineering Laboratory



The EPA Superfund Innovative Technology Evaluation Program (SITE Program) has successfully demonstrated the Terra-Kleen solvent extraction system's ability to reduce polychlorinated biphenyl (PCB) concentration in soils to less than 2 milligrams per kilogram (mg/kg). This is equivalent to the Toxic Substances Control Act's (TSCA) incineration performance guidance level. The Terra-Kleen solvent extraction system has overcome many of the soil handling, contaminant removal and regulatory restrictions that have made it difficult to implement a cost-effective PCB soil treatment system.

The Terra-Kleen system is a batch process that operates at ambient temperatures and removes organic contaminants from soils using proprietary solvents. After soils are washed with solvent, contaminated solvent passes through a solvent recovery unit, where contaminants are separated from the solvent and concentrated, reducing the contaminant volume for disposal. Terra-Kleen maximizes its waste reduction potential by: (1) recycling the extraction solvent as part of the routine system operations; (2) maintaining a closed-loop process to reduce volatile emissions; and (3) concentrating organic contaminants.

For the initial treatability studies portion of the demonstration, the SITE Program obtained 1-ton batches of soil from each of three PCB-contaminated sites and shipped the soil to Terra-Kleen's testing facility in Okmulgee, Oklahoma. Soils were also obtained from Sites 4 and 6 at the Naval Air Station North Island (NASNI) near San Diego, California and from a third site in Anchorage, Alaska. Analyses of all demonstration soils revealed that Aroclor 1260 was the only PCB mixture present. PCB concentrations in untreated soils ranged from 17 to 640 mg/kg. Following treatment, PCB removal efficiencies ranged from 95 to 99%.

Successful removal of PCBs during the treatability study led to a pilot-scale demonstration at NANSI in June 1994. Treated soil concentrations for the NASNI Site 4 pilot-scale demonstration were consistently below 2mg/kg. Untreated PCB concentrations in the soil had ranged from 129 to 168 mg/kg; removal efficiency rates ranged from 98.7 to 98.9%. Completion of the pilot-scale demonstration at NASNI has encouraged the U.S. Navy to select Terra-Kleen to implement full-scale remediation at three NANSI PCB-contaminated sites, totalling about 5,000 cubic yards of soil.

Additionally, as a result of the PCB pilot-scale results at NANSI, the Navy has chosen TERRA-Kleen to implement a full-scale system to remediate 500 tons of pesticide contaminated soils at NCS-Stockton. There, analytical results of samples collected from the first 20-cubic-yard container of treated soil showed 98% removal for dichlorodiphenyldichloroethane (12.2 mg/kg in untreated soil); 99.4% removal for dichlorodiphenyldichloroethene (1.5 mg/kg in untreated soil); and 98.9% removal of dichlorodiphenyltrichloroethane (80.5 mg/kg in untreated soil). Full-scale remediation began in July 1994.

In addition to PCBs and the pesticides discussed above, the Terra-Kleen system is designed to remove petroleum hydrocarbons, chlorinated hydrocarbons, polynuclear aromatic hydrocarbons, polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans from soils, sludges and sediments.

For more information and to get on the mailing list for reports, call Mark Meckes at EPA's Risk Reduction Engineering Laboratory at 513-569-7348 by phone or at 513-569-7676 by FAX.

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beta source or a photoionization source. These ions then react with analyte molecules, after having been separated by GC, to form ion clusters which are then measured by atmospheric pressure time of flight (IMS). The ions enter a drift region where they move through an applied field toward a collector electrode. The electrode current is monitored continuously, allowing a mobility spectrum to be measured. The specificity is imparted by the ionization preferences of analytes and the mobility differences of the ion clusters. Separations are a function of ion size.

Selectivity of IMS for various analytes is based on the atmospheric

pressure ionization events themselves, which relate to the proton and electron affinities of the analytes, the polarity of the products (i.e., positive or negative ions) and the mobility of those ions. Analytes with higher proton or electron affinities than other constituents of the ambient environment are differentiated and detected easily. Analytes with low affinities can be measured when competing chemicals with higher affinities are not present. Thus, compounds such as benzyl chloride, halogenated compounds, hydrogen cyanide, nitrocompounds (explosives), organophosphorus compounds, phenols, phosphorus trichloride, toluene diisocyanate and vinyl chloride are better suited to analysis by IMS than

are compounds like hexane and benzene.

If your site is used to evaluate the GC-FTIMS, you will get immediate on-site data that will enable you to make immediate decisions. In order to determine the performance of the GC-FTIMS system during field measurement, a selected number of split samples should be sent to an approved laboratory for confirmatory analysis, using approved laboratory methods or a gas chromatography-mass spectrometry.

For more technical information, call Tammy Jones at EMSL-LV at 702-798-2270. But, call Ken Brown at 702-798-2270 if you want to discuss field evaluation of the monitor at your site.

INTERNATIONAL SYMPOSIA ALERT

GROUNDWATER AND SOIL REMEDIATION

Canada's 5th Annual Symposium on Groundwater and Soil Remediation will highlight innovative technologies for ground water and soil remediation. The symposium will be held October 2-6, 1995 in Toronto, Ontario, Canada.

For further information, contact Lise Gendron, Environment Canada, by phone, 819-953-9368; or by Fax 819-953-7253.

MANUFACTURED GAS PLANT REMEDIATION

From September 19-21, EPA will sponsor the International Symposium and Trade Fair on the Cleanup of Manufactured Gas Plants in Prague, The Czech Republic. The goals are to provide an international forum for discussing innovative and state-of-the-art technology and approaches for addressing environmental restoration needs and to provide a venue for U.S. environmental businesses interested in exporting tech-

nology and services. Worldwide participation and business opportunities are being solicited by the symposium.

If you want to present papers and for more information, call Steve James of EPA at 513-569-7877 or John Moerlins of Florida State University (FSU) at 904-644-5524. However, exhibitors call Gene Jones at FSU at 904-644-5516

(continued from page 1)

In economic terms, SVE with bioventing removed over 17,000 kg of contaminant for a total capital cost for the SVE test cell system (covering about 1 hectare) of \$150,000 and semi-annual operation and maintenance approximately \$15,000. This represents a mass removal unit cost of about \$10/kg. Compared to many other techniques, SVE with bioventing is clearly an economical method of removing volatile hydrocarbons from subsoils. The goal of the Strachan bioventing demonstration in the future (Phase II bioventing) is to determine how clean bioventing can get the soil at Strachan, and how long it will take. In December 1993 and October 1994 the subsurface soils

were sampled and analyzed for hydrocarbon concentration and composition, bacterial concentrations, nutrients and soil moisture. The subsoils will be re-sampled in the same locations after the O₂ depletions rates indicate that most or all of the biodegradable hydrocarbons have been removed.

For a more detailed description of background, range and extent of the field demonstrations at the Strachan Gas Plant (including the use of horizontal wells), see the July 1994 issue of "Subsurface Remedial Technologies Newsletter," published by the Canadian Association of Petroleum Producers Public Affairs Group in Calgary, as well as the upcoming April 1995 issue of the same Newsletter. The information presented in this article borrowed heavily from the CAPP newsletters. To obtain a copy of CAPP's newsletters on this project, call Michele White at CAPP at 403-267-1154. Also, the results will be presented at Canada's 5th Annual Symposium on Groundwater and Soil Remediation in Toronto, Canada in October (see "International Symposia Alert" section, p. 4 of this issue of TECH TRENDS for Symposium details).

For more technical information on the project, call Alex Lye, GASReP Manager at 905-336-6438.

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Solid Waste
Emergency Response
(5102W)

EPA 542-N-95-001
March 1995
Issue No. 19

